

Appendix

A Socioeconomic Hurricane Impact Analysis for Coastal North Carolina: Hurricane Floyd

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Executive Summary

What should come as a surprise to no one in our State, North Carolina's coastal plain has experienced substantial growth since the 1970's. While the State, as a whole, has grown by 50 percent in that period, some coastal counties have experienced permanent population growth rates ranging from 250 to 400 percent! Thus, whereas hurricane evacuations would involve about 250,000 permanent residents alone in the 1970's, today such evacuations could involve as many as 370,000. This does not include the additional number of people classifiable as *temporary* (i.e., vacationers). With this explosive growth in the coastal zone has come heightened vulnerability to weather events such as hurricanes since, as Professor Stanley Riggs has noted, development has dangerously and appreciably altered coastal floodplain drainage systems.

The East Carolina University Survey Research Laboratory (SRL), Eastern Carolina University Sociology and Economics faculty, and the Economic Development Administration (EDA), U.S. Department of Commerce, under mission assignment from the Federal Emergency Management Agency (FEMA), worked together to incorporate a telephone survey into the efforts to assess the impact of Hurricane Floyd on businesses in Eastern North Carolina. The research design emphasized the need to collect accurate and valid data documenting the impacts of both the hurricanes and floods on the businesses in the region in a very short time period. A preliminary report was prepared with 1,848 completed interviews. The final sample contained 2,461 businesses. The margin of error was plus or minus 2.0 percent with a 95 percent confidence level. There were no substantive differences between the two reports.

The major findings are:

Overall, almost a quarter of the businesses reported physical damage or an expected loss of market. Almost half reported that they had suffered losses due to a disruption of business. Overall, more than 60,000 businesses suffered one or more types of losses.

- Almost 10 percent of the businesses that experienced some storm damage reduced their labor force. Over half of the firms reporting a reduction in their labor force reduced their employment by only one or two employees. Less than 0.2

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percent reported a reduction of 100 employees or more. The average loss was only 0.52 employee per business. Projected to the entire region, an average loss of 0.52 employee per affected business points to an overall reduction in the labor force of 31,000 jobs.

- While employee injuries were rare, employers had to deal with more than 30,000 employees who were temporarily or permanently displaced.
- Most businesses survived the storms and resumed operations quickly, but many small businesses in the most severely affected region had not been able to resume normal operations at the time of this survey.
- Across the 44 counties, almost 75 percent of the businesses shut down because of the storms and floods. The length of the shutdown was much longer in the severely impacted counties (eight days) than in the counties with minor impacts (five days). Almost all of the businesses were planning to reopen and to stay in the same location.
- Road closures had the longest impacts on businesses that identified infrastructure problems. The closures had the most prolonged impacts on medium and small businesses in the moderate and severe impact counties. Loss of water and electric power were the second and third greatest impact on the areas.
- Before the storms, almost 15 percent of the small businesses and 17 percent of the medium-sized businesses had plans to expand. This dropped to 12 percent of the small and 5 percent of the medium-sized businesses after the storm. Before the storms, almost 25 percent of the large businesses in eastern North Carolina planned to expand, but this number dropped to 7 percent after the storms.
- Most businesses carried some insurance, but almost one in six small businesses reported having no business insurance. While most businesses had liability, property and casualty and fire insurance, most were not insured for loss of revenue due to floods. Less than half reported that their insurance covers the replacement cost of their losses. When asked to estimate the proportion of their losses covered by insurance, the average estimate was 17.6 percent. Large businesses had better coverage than small businesses (29 vs. 15 percent).
- Almost two-thirds of the businesses participated in community relief and recovery, giving an average of about \$5,800 to these recovery efforts.
- The average repair cost for physical damage was \$39,091 for the 375 firms that had repair costs greater than zero.

LOSTREV is the lost revenue due to the disruption of the business from closing, lost production, sales, and clients. The weighted average lost revenue for the 656 firms was \$78,638.

- Overall, there was close to \$1 billion in physical damage and \$4 billion in lost revenue.

Introduction

Until 1996, the perception of many North Carolinians was that the decade of the 1950's, especially Hurricane Hazel, was the benchmark for measuring the severity of the adverse impacts to life and property inflicted upon the State by repetitive severe weather events. Several occurrences have collectively transformed that perception. First, there were the tandem catastrophes of Hurricanes Bertha and Fran in 1996, and then the impact of Bonnie in 1998. The second stems from the changes since Hazel (1954) in the demography and development of Eastern North Carolina. In the aftermath of Bertha and Fran, the State recognized its heightened vulnerability, from the coast to the capital, to damage inflicted by a steady barrage of weather events—hurricanes, tornadoes, and heavy rains. Even less severe weather events, e.g., the flow of Northeasters and Southwesters that consistently batter our coastal counties, especially our barrier islands, have been reconceptualized in the eyes of many citizens and policymakers as common and increasingly hazardous events. In other words, it is recognized that it no longer takes a Hazel, “Storm of the Century (1993),” Bertha, Fran, or Bonnie to inflict extensive damage, injury, and loss of life on the State. Other recurring weather events, including some that have, historically, been viewed as mild or benign—10- year rainfalls, gale force winds, down shears, and small tornadoes—now pose serious threats to public safety and property and need to be prepared for accordingly.

Coastal North Carolina experienced a rather benign weather year in 1997 and some attribute the cause to El Nino. In 1998, on August 25, Hurricane Bonnie, a Category 3, slammed into coastal North Carolina causing \$1.5 billion in evacuation and impact costs, according to a study conducted by the Departments of Sociology, Economics, and Regional Development Services at East Carolina University. A great deal of activity followed the storm, most notably by the North Carolina Division of Emergency Management to accelerate

the development of evacuation models and to continue mitigation efforts initiated following Bertha and Fran.

Following Bonnie, most predictions were, and are, that hurricane activity would pick up in the South Atlantic for a number of climatological reasons, not the least of which was the predictable sequel to El Nino, La Nina. But, it had become fairly clear that such natural hazards need not occur more frequently to cause substantially more damage than in the past. The key reason is the explosive development and increasing population density in the coastal zone east of I-95. The heightened vulnerability of Eastern North Carolina to weather events results, in large part, from the gradual transformation of the region from one of sparsely populated rural and coastal communities comprised predominantly of lower income citizens during the “Hazel” period, to the increasingly urbanized region of higher population density, increased property values, and concentrated coastal development of the 1990’s. Eastern North Carolina now supports a combination of industries, including corporate agriculture and fishing, retirement, recreation, higher education, ecotourism, manufacturing, and soon, a major repository for the transshipment of goods and people through the Global TransPark. As a beautiful and comfortable place to live, work, and play, the region attracts people from all over the nation, indeed, the world.

With the exception of Hyde and Onslow, North Carolina’s *coastal* counties experienced anywhere from a near doubling to quadrupling of population since the 1970’s. During the 1990’s, the most dramatic growth was seen in Brunswick (32 percent since 1990), Currituck (24 percent), Dare (24 percent), and New Hanover (25 percent) counties (see Table I-1). These patterns compare with about 48.5 percent growth statewide from the 1970’s; 14 percent during the 1990’s; and relatively modest growth in other counties in Eastern North Carolina (east of I-95). Thus, during the 1990’s, five coastal counties (Brunswick, Currituck, Dare, New Hanover, Pender) grew at a much more rapid rate than the State as a whole; one, Carteret, grew at the same rate; and two (Hyde and Onslow) had negative growth.

Some *non-coastal* counties have experienced similar trends, as data from Beaufort, Craven, Greene, Nash, Pamlico, Pasquotank, Pitt, and Wayne Counties indicates. This trend toward increased development

and population shows no signs of abating. It has been the defining phenomenon of the 1980's and 1990's and is expected to continue into the millennium. The North Carolina Office of State Planning's Projected Annual County Population Total 1998-2008 estimates an additional 13 percent growth in the State by 2008. Furthermore, this influx of people, and the attendant residential and commercial development, often in locations with a demonstrably higher risk of severe storm impact, has left the region ill-prepared for the level of risk it now faces from repetitive weather related natural hazards.

How population trends translate into coastal plain flood problems has been detailed by Professor Stanley Riggs of East Carolina University's Department of Geology. Riggs notes that urban sprawl converts vast areas of forest and agricultural land to paved and other impervious surfaces, which increases runoff. This results in more frequent and severe flash flooding. Add to this the impact of modifications of drainage systems and you have a recipe for disaster. Streams throughout the eastern part of the State have been channelized, and wetlands ditched and drained. Highway construction creates "road dams," which restrict normal floodplain flow. Storm events occurring prior to the rapid community development noted here resulted in smaller, if any, floods. In fact, Riggs notes that in post-Hazel 1955, three major hurricanes dumped 46 inches of rainfall on the coastal plain during a six week period and while a great deal of destruction resulted, flood levels did not reach the records following the tandem storms known as Dennis and Floyd in Fall 1999. As such, Riggs argues that we have created our own crisis and it will happen again, sooner than we might think. Flood zones will need to be revised, natural drainage systems must be restored, and any rebuilding will have to be grounded in a scientific understanding of river systems. (Reported in the *News and Observer*, 10/14/99.)

During early Fall 1999, Eastern North Carolina found out just how vulnerable the region has become. In late August and early September, Hurricane Dennis pushed up the eastern coastline of the United States and parked itself east of Hatteras Island, North Carolina for nearly a week, forcing mandatory evacuations, stranding island residents, and ruining beach vacations. Easterly winds of up to 110 mph battered the coastline, destroying much of the protective dunes systems as far south as Topsail Island. On September 5, after it was

downgraded to a Tropical Storm and upgraded to Hurricane status, Dennis first dropped southward and then took an easterly and, eventually, a northeasterly course. The storm pushed 10 feet of water ahead of 70-mph winds into the Pamlico and Neuse Rivers, causing considerable damage to property as far east as Washington and New Bern. But it was the rain that set the stage for what was to become North Carolina's most devastating natural disaster in its history. Dennis dropped as much as eight inches of rain on Eastern North Carolina.

After causing 2.6 million people from Florida to New York to evacuate - the largest peacetime evacuation in the nation's history, according to James Lee Witt, Director of FEMA - Hurricane Floyd made landfall on Thursday morning, September 16, pushing northeasterly across Oak Island. The brunt of the winds remained offshore but as many as 20 inches of rain fell on an already saturated Eastern North Carolina, only 10 days after the deluge of rain deposited by Dennis. Rivers in the east rose to as much as 23 feet above flood stage on September 19, driving thousands of Eastern North Carolinians from their homes. The peak shelter population reached nearly 48,000 in 49 Red Cross shelters within a few days. At least 50 people died and, according to Dr. Marieke Van Willigen of East Carolina University, the death rate among the elderly in Eastern North Carolina has doubled since Floyd.

Preliminary assessments of property damage indicated that the most severe impacts occurred in 14 of the counties listed in Table I-2 (Beaufort, Brunswick, Columbus, Duplin, Edgecombe, Greene, Jones, Lenoir, Nash, New Hanover, Pender, Pitt, Wayne, and Wilson). The 16 counties with moderate level of damage were Bertie, Bladen, Carteret, Craven, Cumberland, Halifax, Hertford, Hyde, Johnston, Martin, Northampton, Onslow, Pamlico, Pasquotank, Robeson, and Sampson. Some damage was reported in the remaining 14 counties listed in the table.

Methods of Research: Sampling and Interviewing Protocols

On October 1, 1999, SRL met with FEMA and EDA in Raleigh North Carolina to discuss the possibility of incorporating a telephone survey into their joint efforts to assess the impact of Hurricane Floyd

Appendix I

Table I-1 Population Growth in Eastern North Carolina: 1970-1998 (% change in parens)

County	1970	1980	1990	1998	% 70-98
Beaufort	35,980	40,355 (+12)	42,283 (+5)	43,468 (+3)	(+21)
Bertie	20, 528	21,024 (+2)	20,388 (-3)	20,102 (-1)	(-2)
Bladen	26,477	30,491	28,663	30,770	(+16)
Brunswick	24,233	35,777 (+48)	50, 985 (+43)	67,441 (+32)	(+110)
Camden	5,453	5,829 (+7)	5,904 (+1)	6,320 (+7)	(+16)
Carteret	31,603	41,092 (+30)	52,553 (+27)	59,881 (+14)	(+89)
Chowan	10,784	12,558 (+17)	13,506 (+8)	14,325 (+6)	(+3)
Columbus	46,937	51,037 (+9)	49,587 (-3)	52,261 (+5)	(+11)
Craven	62,554	71,043 (+14)	81,613 (+15)	89,546 (+10)	(+43)
Cumberland	212,042	247,160	274,713	292,744	(+38)
Currituck	6,976	11,089 (+59)	13,736 (+24)	16,947 (+24)	(+143)
Dare	6,995	13,377 (+91)	22,746 (+70)	28,218 (+24)	(+303)
Duplin	38,015	40,952 (+8)	39,995 (-2)	44,639 (+12)	(+17)
Edgecombe	52,531	55,988 (+7)	56,692 (+1)	54,872 (-3)	(+4)
Franklin	26,820	30,055	36,414	44,438	(+66)
Gates	8,524	8,875 (+4)	9,305 (+5)	9,986 (+7)	(+17)
Greene	14,967	16,117 (+8)	15,384 (-4)	18,071 (+18)	(+21)
Halifax	54,354	55,076 (+1)	55,516 (+1)	55,182 (-1)	(+2)
Harnett	49,667	59,570	67,833	83,590	(+68)
Hertford	24,439	23,368 (-4)	22,523 (-4)	21,684 (-4)	(-11)
Hyde	5,571	5,873 (+5)	5,411 (-8)	5,301 (-2)	(-5)
Johnston	61,737	70,599	81,306	107,717	74%
Jones	9,779	9,705 (+1)	9,414 (-3)	8,786 (-7)	(-10)
Lenoir	55,204	59,819 (+8)	57,274 (-4)	59,024 (+3)	(+7)
Martin	24,730	25,948 (+5)	25,078 (-3)	25,545 (+2)	(+3)
Nash	59,122	67,153 (+14)	76,667 (+14)	88,469 (+15)	(+50)
New Hanover	82,996	103,471 (+9)	120,284 (+16)	149,975 (+25)	(+81)
Northampton	23,099	22,195 (-4)	20,798 (-6)	20,837 (0)	(-10)
Onslow	103,126	112,784 (+9)	149,838 (+33)	148,324 (-1)	(+44)
Pamlico	9,467	10,398 (+10)	11,368 (+9)	12,037 (+6)	(+27)
Pasquotank	26,824	28,462 (+6)	31,298 (+10)	35,146 (+12)	(+31)
Pender	18,149	22,262 (+23)	28,855 (+30)	38,424 (+33)	(+12)
Perquimans	8,351	9,486	10,447	10,947	(+31)
Pitt	73,900	90,146 (+22)	108,480 (+20)	123,155 (+14)	(+67)
Robeson	84,842	101,610	105,170	114,430	(+35)
Sampson	44,954	49,687	47,297	53,312	(+19)
Scotland	26,929	32,273	33,763	35,201	(+31)
Tyrrell	3,806	3,975 (+4)	3,856 (-3)	3,625 (-6)	(-5)
Vance	32,691	36,748	38,892	41,690	(+28)
Wake	229,006	301,429	426,301	574,828	(+151)
Warren	15,340	16,232	17,265	18,916	(+23)
Washington	14,038	14,801 (+5)	13,997 (-5)	13,078 (-6.6)	(-7)
Wayne	85,408	97,054 (+14)	104,666 (+8)	114,246 (+9)	(+34)
Wilson	57,486	63,132 (+10)	66,061 (+5)	69,133 (+5)	(+20)
North Carolina	5,082,059	5,881,776 (14)	6,628,637 (13)	7,544,366 (14)	(+49)

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on businesses in Eastern North Carolina. The primary problem was the extent of the damage. These discussions resulted in a general understanding of a methodology to assess the impacts of the hurricane and floods on businesses. The research design emphasized the need to collect accurate and valid data documenting the impacts of both the hurricanes and floods on the businesses in the region in a very short time period. On Saturday October 2, a formal proposal was submitted; it was revised on October 3 and approved October 4.

FEMA and EDA identified 44 North Carolina counties that were affected by Hurricane Floyd and the floods. The 14 severely impacted counties included Beaufort, Brunswick, Columbus, Duplin, Edgecombe, Greene, Jones, Lenoir, Nash, New Hanover, Pender, Pitt, Wayne, and Wilson. The 16 counties with moderate level of damage were Bertie, Bladen, Carteret, Craven, Cumberland, Halifax, Hertford, Hyde, Johnston, Martin, Northampton, Onslow, Pamlico, Pasquotank, Robeson, and Sampson. The 14 counties with minor overall damage were Camden, Chowan, Currituck, Dare, Franklin, Gates, Harnett, Perquimans, Scotland, Tyrrell, Vance, Wake, Warren and Washington.

SRL worked with Survey Sampling, Inc. to locate businesses in the 44-impacted counties. Survey Sampling, Inc. is a national firm specializing in drawing samples for scientific surveys conducted by businesses and academics. Survey Sampling Inc. maintains a comprehensive business database that contains more than nine million U.S. businesses. This database is compiled from a number of sources, including telephone directories, government listings, vertical files (bank records, school files, etc.), accounts receivable records, trade directories, city directories, and customer files. Information on businesses is verified by telephone on an on-going basis. The database is updated quarterly. Overall, Survey Sampling identified over 96,000 businesses in these 44 counties. There were 34,349 business in counties with minor damage, 29,939 businesses in counties with moderate damage and 32,214 businesses in counties with severe damage.

Both the size and number of businesses impacted by the hurricane and floods have significant impacts on the community. Disruption of a single large business can have an impact on the lives of hundreds of families and social institutions that depend on these people. While the impact of damage to a small business is less noticeable, there are

so many more small businesses that their cumulative impact can be just as strong. Businesses were divided according to the number of employees. Businesses were classified as small (1 to 9 employees), medium (10 to 99 employees) or large (100 or more employees). Survey Sampling Inc. identified 78,285 small businesses, 16,983 medium sized businesses and 1,234 large businesses in the 44 counties.

A questionnaire was developed and revised five times over the course of this study. The original questionnaire was modeled after a questionnaire that had been used for face-to-face interviews in other disasters. This was revised to gather some additional information but it later had to be shortened. The most important revision was creating closed-ended questions to assess damages. FEMA field workers could often get a business owner to estimate the extent of the damage done to the business. Last January, SRL had successfully collected dollar figure estimates of the damage done by Hurricane Bonnie. Given the prior success of both organizations, the open-ended estimates seemed like a reasonable approach. However, this needed to be revised for the current survey. The telephone survey did not have the same level of trust as the face-to-face interviews or the elapsed time of the Hurricane Bonnie interviews. The Bonnie interviews occurred six months after the storm. At that point in time, business owners had already documented their losses in exact dollar figures. Less than one month after Floyd, they had not yet developed exact estimates and were very reluctant to offer an estimate even when the strongest possible assurances were given. Once categories were developed, cooperation improved dramatically. This mistake significantly slowed the research process. The final questionnaire is included as Appendix A.

The telephone interviewing was conducted by 30 East Carolina University students SRL hired for this project. Interviewers were given a three-hour training session that covered general research methodology as well as the special requirements of this project. In addition, five supervisors were hired to monitor the telephone interviews, assist with problems, and maintain the level of quality. Four graduate assistants scheduled the interviewing shifts, worked with the Computer Assisted Telephone Interview (CATI) system, checked for data errors, and

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Table I-2 Number of Businesses in Each North Carolina County Impacted by Hurricane Floyd

County	Flood Damage Level	Total Small Businesses	Total Medium Businesses	Total Large Businesses
Beaufort	Severe	1362	237	15
Brunswick	Severe	2124	344	17
Columbus	Severe	1408	252	21
Duplin	Severe	1197	190	13
Edgecombe	Severe	1087	236	29
Greene	Severe	283	42	4
Jones	Severe	224	36	2
Lenoir	Severe	1864	384	36
Nash	Severe	2026	495	54
New Hanover	Severe	6072	1436	87
Pender	Severe	770	125	6
Pitt	Severe	3291	793	47
Wayne	Severe	2641	523	40
Wilson	Severe	1892	471	38
Subtotal		26241	5564	409
Bertie	Moderate	452	72	7
Bladen	Moderate	594	113	10
Carteret	Moderate	2001	363	16
Craven	Moderate	2339	497	26
Cumberland	Moderate	5354	1371	83
Halifax	Moderate	1255	264	17
Hertford	Moderate	572	112	14
Hyde	Moderate	174	34	3
Johnston	Moderate	2758	495	36
Martin	Moderate	598	121	7
Northampton	Moderate	367	71	6
Onslow	Moderate	2886	574	23
Pamlico	Moderate	250	44	2
Pasquotank	Moderate	1119	222	12
Robeson	Moderate	2437	493	52
Sampson	Moderate	1407	203	13
Subtotal		24563	5049	327
Camden	Minor	122	16	0
Chowan	Minor	393	81	7
Currituck	Minor	494	68	1
Dare	Minor	1833	335	6
Franklin	Minor	812	130	12
Gates	Minor	176	37	0
Harnett	Minor	1492	297	26
Perquimans	Minor	276	32	1
Scotland	Minor	751	173	30
Tyrrell	Minor	80	8	1
Vance	Minor	1033	217	25
Wake	Minor	19455	4875	379
Warren	Minor	253	42	4
Washington	Minor	311	59	6
Subtotal		27481	6370	498
Total		78285	16983	1234

helped analyze the data. Most of these people had worked on previous surveys for SRL.

The calling was done between October 11 and November 5, 1999. The entire telephone survey was completed employing IBM computers and Sawtooth Software's Ci3 system. This software allows researchers to program the necessary skip and branch patterns and provides automatic data entry on the microcomputer. When possible, Ci3 also verifies that the data entered is a valid response to the question appearing on the computer screen. This computerized system of automatic data entry and verification significantly reduces the potential error rate.

When businesses were called, the interviewers explained they were calling from the SRL on behalf of the United States government to assess the effects of Hurricane Floyd on businesses. They explained they needed to talk with someone who could discuss the types of losses that this business had experienced at this location. Then they identified the name of the appropriate person. If that person did not have time when the interviewer called, they scheduled a time to call back when it was most convenient for the respondent. Calls were returned promptly at the scheduled times.

Respondents were assured that this information was being collected to identify economic needs and available resources of disaster-impacted communities in North Carolina. They were also informed that while some questions within this survey may duplicate some of the questions that will be asked in other interviews, the answers to these questions would not be used to determine individual funding needs or to complete specific damage surveys.

Interviews were conducted between 9 am and 5 pm Monday through Friday. Some calls were placed between 5 pm and 7 pm to businesses that maintained evening hours. If a respondent asked to be called back at a time outside of these hours, the respondent was called at the time requested. Supervisors monitored the work of all interviewers and reviewed it for accuracy.

When the telephone interviews uncovered a business that did not have a working telephone, field interviewers in local communities attempted to locate someone with knowledge of the business. Field interviews were conducted and added to the database. This

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significantly improved the coverage for businesses that had sustained significant damage and had not managed to reopen by the time of the survey. The final sample contained 2,461 businesses. The margin of error was plus or minus 2.0 percent with a 95 percent confidence level.

Findings

Businesses in these 44 Eastern North Carolina counties expect to encounter some damages from high winds and water, and losses due to evacuations of employees and customers but the damages inflicted by 1999 hurricanes and floods were uniquely challenging. Table I-3 displays the type of economic activity that

Table I-3 Types of Economic Activities in the Three Impact Regions

Economic Sector	Amount of Damage			Total
	Minor	Moderate	Severe	
1 Construction	6.76	5.49	5.95	6.15
2 Manufacturing	8.44	14.71	20.95	12.91
3 Transportation/Utilities	1.96	2.09	3.10	2.20
4 Retail	20.44	20.97	17.38	20.11
5 Wholesale	2.67	3.51	3.57	3.14
6 FIRE	7.02	3.51	3.81	5.17
7 Services	31.02	29.31	27.14	29.72
8 Tourism	4.18	1.65	4.05	3.22
9 Agricultural Services	3.11	5.05	2.38	3.71
10 Other	14.40	13.72	11.67	13.68
Total (N=2456)	100.00	100.00	100.00	100.00

characterized the businesses in the sample. This includes all businesses called, not just those that sustained some damage.

The interview quickly turned to the question of damage and the respondents were asked if their business had any physical damage from the hurricane and its aftermath. Next they were asked if their business had any losses due to the disruption of business. Finally they were asked if they expected their business to suffer future loss of market share or reduction in growth. Table I-4 shows the proportion of businesses in each of the nine subregions that reported these kinds of losses. Overall, about 25 percent of the businesses reported physical damage or an expected loss of market.

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Table I-4 Proportion of Businesses with Three Types of Storm Damage

Number of Employees	Amount of Damage	Number of Businesses With		
		Physical Damage	Business Interruption	Loss of Market
Small	Minor	0.12	0.39	0.13
	Moderate	0.30	0.62	0.28
	Severe	0.35	0.60	0.25
	Average	0.25	0.53	0.22
Medium	Minor	0.18	0.48	0.17
	Moderate	0.27	0.69	0.25
	Severe	0.48	0.77	0.27
	Average	0.31	0.64	0.22
Large	Minor	0.12	0.33	0.06
	Moderate	0.25	0.51	0.12
	Severe	0.34	0.64	0.16
	Average	0.23	0.48	0.11

Fifty-five percent reported they had suffered losses due to a disruption of business and 62 percent reported one or more losses. These storms could hurt businesses in so many different ways that many businesses that appeared to escape unharmed had suffered serious blows.

The proportion of businesses suffering each type of loss is projected to estimate the total number of businesses impacted by the storms

Table I-5 Number of Businesses with Three Types of Storm Damage

Number of Employees	Amount of Damage	Number of Businesses	Number of Businesses With		
			Physical Damage	Business Interruption	Loss of Market
Small	Minor	27,481	3,335	10,672	3,535
	Moderate	24,563	7,247	15,333	6,887
	Severe	26,241	9,184	15,745	6,560
	Total	78,285	19,766	41,750	16,982
Medium	Minor	6,370	1,138	3,052	1,052
	Moderate	5,049	1,367	3,464	1,258
	Severe	5,564	2,683	4,272	1,490
	Total	16,983	5,188	10,788	3,801
Large	Minor	498	62	164	30
	Moderate	327	82	167	38
	Severe	409	140	262	67
	Total	1,234	284	593	134
Total	Minor	34,349	4,535	13,888	4,617
	Moderate	29,939	8,696	18,964	8,183
	Severe	32,214	12,007	20,279	8,117
	Total	96,502	25,238	53,131	20,917

and floods in Table I-5. The total number of businesses of each size is based on the information supplied by Survey Sampling Inc. This table indicates that almost 20,000 small businesses incurred physical damage, 42,000 small businesses had their business disrupted, and 17,000 expected to lose market share because of the storms. Another 5,000 medium-sized businesses (10 to 99 employees) had physical damage, 11,000 were disrupted, and almost 4,000 expected to lose market share. Overall, about 60,000 businesses suffered one or more types of losses. Most of these losses are small (under \$10,000) and will not attract media attention or qualify for relief programs. These figures indicate that the damage done to Eastern North Carolina goes beyond the terrible physical damage that was so visible on television.

One impact of this extensive disruption is seen on employees (see Table I-6). For most businesses, the storms did not affect the number of employees. However, almost 10 percent of the businesses that experienced some storm damage reduced their labor force. For over half of the firms who reported a reduction in their labor force, it was only a reduction of one or two employees. Only 0.2 percent reported a reduction of 100 employees or more. The average loss is only 0.52 employee per business. But this is why the storm has such an effect on this region. Looking at life in many parts of these counties, things seem to be back to normal but even in these normal areas businesses are tightening their belts to pay for the losses incurred during the storms. Projected to the entire region, an average loss of 0.52 employee per affected business points to an overall reduction in the labor force of more than 31,000 jobs mostly from reductions of 1 or 2 employees.

Businesses reported that employee injuries were relatively rare, but they still amounted to almost 3,700 injuries across the 44-county region. This includes all known injuries and not just serious injuries or injuries that happened at work. More businesses had to deal with employees who were displaced by the storms. Overall, 21 percent of the businesses reported one or more displaced employees. These data suggest that employers had to deal with over 30,000 displaced employees.

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Table I-6 Hurricane Floyd's Impact on Employees in Eastern North Carolina

Size	Damage	Employees Before Hurricane	Employees After Hurricane	Average Change in Employees	No. of Injured Employees	No. of Displaced Employees
1.00 Small	1.00 Minor	9.87	9.61	-0.25	0.03	0.12
	2.00 Moderate	7.25	7.21	-0.04	0.03	0.30
	3.00 Severe	3.84	3.64	-0.20	0.02	0.27
	Total	6.63	6.48	-0.16	0.03	0.24
2.00 Medium	1.00 Minor	27.58	26.77	-0.82	0.10	0.80
	2.00 Moderate	45.02	28.24	-0.84	0.18	0.98
	3.00 Severe	32.85	29.63	-3.22	0.09	1.96
	Total	35.33	28.35	-1.76	0.12	1.30
3.00 Large	1.00 Minor	329.76	325.97	-3.79	2.12	1.29
	2.00 Moderate	273.61	271.70	-0.72	0.45	5.24
	3.00 Severe	221.39	213.31	-8.20	2.23	14.22
	Total	267.03	261.94	-4.81	1.69	7.98

Table I-7 Hurricane Floyd's Impact on Business Operations

Number Of Employees	Amount of Damage	Proportion of Businesses Currently Operating	Proportion of Businesses That Shut Down	No. of Days Business Was Shut Down	Proportion With Infrastructure Issues	Proportion NOT Relocating
Small	1.00 Minor	96.18	62.30	3.53	17.83	96.82
	2.00 Moderate	96.77	73.96	6.35	27.08	95.85
	3.00 Severe	85.43	81.74	9.11	32.75	91.07
	Total	92.30	73.90	6.90	26.84	94.28
Medium	1.00 Minor	97.70	56.32	3.28	17.24	97.67
	2.00 Moderate	94.95	73.74	6.04	24.49	97.98
	3.00 Severe	93.16	78.45	6.83	30.17	94.87
	Total	95.05	70.53	5.75	24.58	96.69
Large	1.00 Minor	100.00	50.00	1.84	20.00	100.00
	2.00 Moderate	100.00	80.00	2.31	20.00	100.00
	3.00 Severe	100.00	71.43	3.90	28.57	100.00
	Total	100.00	68.75	2.95	23.53	100.00
Total	1.00 Minor	96.55	60.74	3.46	17.73	97.04
	2.00 Moderate	96.65	73.98	6.26	26.54	96.46
	3.00 Severe	87.16	80.99	8.61	32.19	91.78
	Total	92.99	73.15	6.64	26.36	94.82

Most businesses (93 percent) survived the storms and were currently operating at the time of the survey (see Table I-7). However, almost 10 percent of the small businesses in the most severely impacted region had not yet been able to resume normal operations. Across the 44 counties, almost 75 percent of the businesses shut down because of the storms and floods. The length of the shutdown was much longer in the severely impacted counties (eight days) than in the counties with minor impacts (five days). Less than one half of 1 percent are not

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planning to reopen and most (95 percent) are planning to stay in the same location.

The respondents were asked, “Were there infrastructure issues that prevented the business from operating at the pre-disaster capacity?” Overall, 26.4 percent indicated that there were infrastructure issues ranging from 18 percent in the minor impact counties to almost one-third in the severe impact counties. Given the fact that almost 75 percent of the businesses reported shutting down and only 25 percent reported physical damage to their business, this figure seems low. One possibility is that while this question works well in a field setting where the respondent can see the relevant infrastructure elements identified (water, power, sewer, roads, trash pickup, etc.), it did not

Table 1-8 The Impact of Infrastructure Disruption on Eastern North Carolina Businesses

Number of Employees	Amount of Damage	Mean Number of Days Business Was Impacted by Problems With						
		the Water System	the Sewer System	Telephone System	Electric Power	Road Closures	Parking	Trash Removal
Small	Minor	3.58	0.50	1.34	1.63	2.88	0.50	0.78
	Moderate	3.10	1.46	1.76	3.07	4.90	0.90	2.25
	Severe	5.94	1.78	4.67	4.89	6.89	1.44	3.39
	Average	4.51	1.45	3.06	3.68	5.48	1.09	2.54
Medium	Minor	2.18	0.60	2.73	1.49	2.80	0.43	1.23
	Moderate	5.93	0.97	1.82	2.28	6.15	0.26	1.84
	Severe	4.79	0.85	3.36	3.00	9.21	2.36	2.43
	Average	4.63	0.84	2.73	2.47	6.93	1.29	1.99
Large	Minor	1.50	0.13	1.13	2.13	2.71	0.47	0.20
	Moderate	2.65	0.23	1.04	2.29	4.59	0.48	0.04
	Severe	8.69	2.91	3.32	2.83	4.89	2.08	1.45
	Average	5.87	1.73	2.34	2.56	4.43	1.36	0.83
Total	Minor	3.26	0.52	1.64	1.60	2.86	0.48	0.87
	Moderate	3.58	1.37	1.77	2.93	5.11	0.79	2.17
	Severe	5.75	1.62	4.41	4.51	7.31	1.62	3.19
Overall Average		4.54	1.34	2.99	3.44	5.74	1.13	2.42

work over the telephone where the respondents were left to their own resources to define the term. They could for example have thought that the question was referring to “private infrastructure” such as their buildings, computer systems, or machinery rather than public infrastructure. Only those who reported infrastructure issues were asked about the impact of public infrastructure problems on the operation of their business. Each of the respondents who reported that infrastructure problems had impacted the operation of their

business was asked the number of days that the business was impacted by seven potential problems. The results are presented in Table I-8.

Road closures had the longest impacts on businesses. These closures had the most prolonged impacts on medium and small businesses in the moderate and severely impacted counties. Problems experienced by water systems had the second longest impact, especially on the large businesses in the severely impacted counties. Loss of electric power represented the third greatest impact. Loss of electricity had its greatest impact on small businesses in moderate and severely impacted counties.

Table I-9 Hurricane Floyd's Impact on Business Expansion Plans

Number of Employees	Amount of Damage	Proportion of Businesses Planning to Expand Before	Proportion of Businesses Planning to Expand Now
Small	Minor	13.19	12.14
	Moderate	21.58	1.96
	Severe	9.17	7.69
	Average	14.91	12.14
Medium	Minor	19.74	4.94
	Moderate	18.52	5.99
	Severe	13.83	3.13
	Average	17.13	5.26
Large	Minor	25.00	3.70
	Moderate	20.00	7.02
	Severe	20.00	9.17
	Average	21.43	6.98

Respondents were asked about their business plans to expand. The results are presented in Table I-9. Before the storms, almost 15 percent of the small businesses and 17 percent of the medium-sized businesses had plans to expand. This dropped to 12 percent of the small businesses and 5 percent of the medium-sized businesses after the storm. The most dramatic change occurred in the plans of the large businesses. Before the storms hit, almost 25 percent of the large businesses planned to expand but this dropped to 7 percent after the storms struck Eastern North Carolina. Since this survey was in the field right after the storms, this finding should be taken less as a prediction of future behavior and more as an indication of the impact of the storms on people's sense of the future.

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Table I-10 Insurance Coverage Carried by Businesses Impacted by Hurricane Floyd

Number of Employees	Amount of Damage	Proportion of Businesses That Have						
		Any Insurance	Liability Insurance	Property & Casualty Insurance	Fire Insurance	Loss of Revenue Insurance	Flood Insurance	Replacement Cost Coverage
Small	Minor	82.59	88.72	76.41	78.46	20.00	21.54	35.29
	Moderate	78.06	86.06	78.88	76.89	27.20	15.54	48.37
	Severe	87.01	80.47	80.70	70.85	17.20	7.29	38.34
	Average	82.87	84.28	79.06	74.65	21.07	13.43	40.84
Medium	Minor	90.77	86.67	85.25	85.00	39.34	32.79	35.00
	Moderate	94.67	87.67	82.19	80.82	38.36	13.70	43.06
	Severe	87.65	88.73	84.72	74.65	21.13	7.04	40.58
	Average	90.95	87.75	83.98	79.90	32.68	17.07	39.80
Large	Minor	100.00	100.00	100.00	100.00	50.00	33.33	33.33
	Moderate	100.00	75.00	75.00	75.00	50.00	33.33	33.33
	Severe	100.00	80.00	80.00	80.00	60.00	40.00	40.00
	Average	100.00	83.33	83.33	83.33	53.85	36.36	36.36

To help assess the impact of the losses, businesses were asked about their insurance coverage. These results are presented in Table I-10.

While most businesses carried some insurance, almost one of every six small businesses reported having none. Also, while most businesses have liability, property and casualty, and fire insurance, most are not insured for loss of revenue or floods. Less than half reported that their insurance covers the replacement cost of their losses. When asked to estimate the proportion of their losses that were covered by insurance, the average estimate was 17.6 percent.

Table I-11 Business Participation in Community Assistance and Recovery Efforts

Number of Employees	Amount of Damage	Proportion of Businesses		Average Value of	
		Receiving Community Assistance	Community Assistance Received	Supporting Community Assistance	Community Assistance Provided
Small	Minor	0.43	\$10,000	51.59	\$842
	Moderate	4.72	\$959	55.70	\$1,616
	Severe	2.54	\$250	58.74	\$2,047
	Average	2.48	\$1,039	55.29	\$1,419
Medium	Minor	1.25	\$4,000	60.25	\$2,801
	Moderate	4.72	\$1,082	66.41	\$9,061
	Severe	10.56	\$1,560	71.63	\$40,327
	Average	5.36	\$1,547	65.81	\$17,778
Large	Minor	0.00	\$500	58.33	\$130,527
	Moderate	0.00	\$4,150	62.50	\$60,193
	Severe	9.09	\$3,724	70.00	\$49,417
	Average	3.23	\$3,535	63.33	\$81,502

Large businesses had slightly better coverage than small businesses (29 percent vs. 15 percent).

Many communities also organized community assistance and recovery programs. Almost two-thirds of the region's businesses participated in these programs (Table I-11). While a majority of businesses of all types participated, the value of the contribution made by larger businesses was substantially greater. Overall, businesses gave an average of about \$5,800 to these recovery efforts. The unusually large value for large business in minor impact counties includes one power company that donated \$10 million to the recovery effort.

Models of Estimated Repair Costs and Lost Revenue from Hurricane Floyd

The purpose of this report is to analyze the economic damage data from the FEMA survey conducted by SRL. The SPSS data was converted to SAS data and recoded for analysis. Minor changes were made to some of the variables. The most major of these was the top-coding of the AMTREV variable at \$18 million. A few likely key punch errors were also corrected. Cases were dropped if the minority ownership question was not answered. The sample size was 1,725 firms. Preliminary regression models were estimated in SAS. The variables in the final pretest models were exported and the sample selection regression models were estimated using the LIMDEP econometric software.

Table I-12 Data Summary

	Mean	Std.Dev.	Cases
REPRCOST	\$39,048	\$304,163	348
LOSTREV	\$80,654	\$901,920	627
EMPLOYED	11.69	39.86	1725
EMPLOYED	11.31	40.31	348
EMPLOYED	12.41	35.49	627
LOGEMPLY	1.68	0.92	1725
SERV	0.37	0.48	1725
CONS	0.06	0.24	1725
TOUR	0.02	0.14	1725
SERV	0.37	0.48	1725
AGRI	0.04	0.20	1725
HOWLONG	4.74	6.90	1108
ROADCLOS	1.15	3.84	1108
TRASH	0.36	2.24	1108
MINORITY	0.30	0.46	1725

The data used for this analysis is summarized in Table I-12. The two dependent variables are REPRCOST and LOSTREV. REPRCOST is the sum of estimated repair costs to buildings, grounds, contents of buildings, inventory, and rolling stock. The average repair cost was \$39,091 for the 375 firms that had repair costs greater than zero. LOSTREV is the lost revenue due to the disruption of the business from closing, lost production, sales, and clients. The weighted average lost revenue for the 656 firms was \$78,638.

The size of the firm is an independent variable common to both models. The variable is equal to the number of employees (EMPLOYED). The weighted average number of employees is about 11. This number is slightly lower for those firms that have positive repair costs and slightly higher for firms with lost revenue. Other independent variables included in the models are SERV (a dummy variable for service industry), CONS (construction industry), TOUR (tourism/hospitality industry), and AGRI (agricultural industry). HOWLONG measures the number of days the firm was closed. ROADCLOS is the number of days that road closure impacted the operation of the business. TRASH indicates the number of days that trash removal impacted the operation of the business. MINORITY indicates whether the firm is minority-owned.

GROUP1 and GROUP2 are variables that indicate county groups. The counties chosen for each group were based on simple correlations between a county dummy variable and dummy variables for whether the firm had positive repair costs (D1) and positive lost revenue (D2). These groupings are intended to measure the effect of impacts of similar locations on firms. Counties in Group 1 are Brunswick, Duplin, Greene, Jones, Nash, Wilson, Bertie, Bladen, Carteret, Onslow, and Dare. Counties in Group 2 are Chowan, Franklin, Gates, Perquimans, Scotland, Vance, Wake, and Warren. Other possibilities for county groupings are by river basin.

Sample selection models are used to estimate the determinants of repair costs and lost revenues (see Appendix). In general, the sample selection model first determines why a firm suffered losses. This is achieved through a probit model with the number of employees and county groups as dependent variables. Next, the magnitude of the losses is the dependent variable in a regression model with characteristics of the firm as independent variables. An additional variable is the sample selection variable (Lambda) which is created

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from the probit model. If the coefficient on this variable is statistically different from zero then a regression model without the sample selection rule would produce biased estimates.

Repair Costs

The model of the factors affecting repair costs is presented in Table I-13. Firms that reside in County Group 1 are more likely to experience positive repair costs than the other counties. Firms that reside in County Group 2 are less likely to experience positive repair costs than the other counties. The size of the firm does not affect estimated repair costs.

The log of repair cost is used as the dependent variable to improve statistical fit of the regression model. The model explains about 8 percent of the variation in the independent variable. This number appears low but it is reasonable for cross section data. Firm size increases the repair costs. Since both the dependent and independent variables are logged, the coefficient is the ratio of the percentage change in costs caused by a percentage change in employees (the elasticity). A 100 percent increase in the number of employees leads to a 21 percent increase in repair costs. In other words, as firm size doubles the repair costs increase by 21 percent.

Table I-13 Selection Model of Repair Costs

Dependent variable = D1	Coefficient	t-ratio
Constant	-0.887	-10.897
LOGEMPLY	0.019	0.912
GROUP1	0.435	5.409
GROUP2	-0.650	-6.443
Chi-square	109.250	
Sample = 1725		
Dependent variable = log(REPRCOST)		
ONE	10.370	15.895
LOGEMPLY	0.211	1.970
SERV	-0.483	-2.414
CONS	0.649	1.480
TOUR	1.272	2.687
MINORITY	0.211	1.044
LAMBDA	-1.372	-2.847
F-stat	5.150	
R-squared	0.083	
Sample = 348		

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The coefficient on a dummy variable is approximately the percentage difference in the dependent variable across groups represented by the dummy variable. Using this interpretation, firms in the service industry have 48 percent lower repair costs than all others. Firms in the tourism industry have 127 percent higher repair costs. Firms in the construction industry and firms owned by minorities do not have statistically different repair costs. Finally, the sample selection variable is negative and statistically significant. This indicates that failure to account for the risk of damages would bias regression coefficients.

Lost Revenue

The model of the factors affecting lost revenue is presented in Table I-14. Similarly to the previous model, firms that reside in County Group 1 (2) are more (less) likely to experience positive repair costs than the other counties. In contrast to the previous model, the size of the firm does affect the probability of lost revenue. As the firm size increases, the likelihood that revenue was lost also increases.

The log of lost revenue is used to improve statistical fit of the regression model. The amount of variation in the dependent variable

Table I-14 Selection Model of Lost Revenue

Dependent variable = D2	Coefficient	t-ratio
Constant	-0.460	-6.571
LOGEMPLY	0.044	2.416
GROUP1	0.288	3.926
GROUP2	-0.496	-6.464
Chi-square	86.070	
Sample = 1725		
Dependent variable = log(LOSTREV)		
Constant	8.429	18.106
LOGEMPLY	0.638	8.705
SERV	-0.363	-2.559
AGRI	1.465	3.915
HOWLONG	0.001	0.888
ROADCLOS	0.064	4.805
TRASH	0.034	1.859
MINORITY	-0.700	-4.706
LAMBDA	-0.702	-1.668
F-stat	25.48	
R-squared	0.248	
Sample = 627		

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explained by the independent variable is 25 percent. Firm size increases the repair costs. A 100 percent increase in the number of employees leads to a 64 percent increase in repair costs.

Firms in the service industry have 36 percent lower repair costs than all others. Firms in the agriculture industry have 146 percent higher repair costs. In general, the number of days the business was impacted does not affect lost revenue. However, the number of days that roads were closed and the number of days that trash removal impacted the firm increased costs. Each day for which roads were closed increased lost revenues by about 6 percent. Each day for which trash removal impacted the firm increased lost revenues by about 3 percent. Firms owned by minorities do have statistically different revenue losses. Minority owned firms lose 70 percent more revenue than non-minority owned firms.

Appendix

The following equations describe a probit selection model and a linear regression model

$$\text{Pr}(z) = a'x_1 + u$$

$$z = 1 \text{ if } y > 0, z = 0 \text{ if } y = 0$$

$$\log(y) = b'x_2 + e$$

where z is the dummy indicator variable for positive repair costs (or positive lost revenue), y is the magnitude of repair costs (lost revenue), x_1 and x_2 are vectors of independent variables which can overlap, e and u are error terms which have a bivariate normal distribution. Values of y and x are only observed when z equals 1 ($y > 0$). This model is due to Heckman.